

Corporate R&D Center

Naval Research Laboratory

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Attn: Dr. Francis J. Kub

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Attention: Dr. Francis J. Kub

Subject: Monthly Progress Report - December, 1996

Reference: SiGe Power HBT

Gentlemen:

### 1.0 Introduction

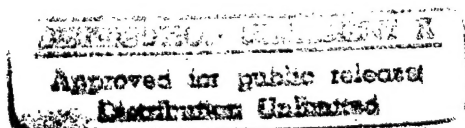
The objective of this program is the development and demonstration of a viable SiGe power HBT device design and associated processes that will demonstrate >1 Watt of output power at 6 and 8 GHz.

### 2.0 Objectives for the Reporting Period

- 2.1 Purchase order to be placed for mask set changes for the implementation of thin film ballast resistors on the SiGe2 and BUR50 devices.
- 2.2 Testing will resume at CR&D to compare the RF performance of the poly-emitter and poly-all processes at 1.88 GHz.
- 2.3 The load-pull test system will be calibrated for 6 GHz using the new (replacement) bias-tee. Testing at 6 GHz will resume at PHO and at CR&D when the new MNM capacitors become available; expected in early January 1997.
- 2.4 Start wafer processing of the new MNM capacitors to be used in the input impedance matching of the SiGe2 and BUR50 devices.

### 3.0 Progress During the Reporting Period

- 3.1 The design and layout work to incorporate thin film ballast resistors into both SiGe2 and BUR50 designs has been initiated and the work is on-going. A new wafer run start of both SiGe2 and BUR50 designs has been initialized utilizing the NRL collector epitaxial design anticipating receipt of these thin film ballast resistor masks. SIMS analysis will be performed to verify the SiGe and dopant levels in the base structure.



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The alternative approach to adding ballasting to the SiGe2 and/or BUR50 designs involve initially forming the resistors out of polycrystalline silicon at very high temperatures; followed by the selective growth of the SiGe base is still in the design phase. A new start will be initiated after receipt of new masks.

- 3.2 Testing samples were prepared of the SiGe2 (lot 15) wafers which feature poly-emitter grounded-base devices. Impedance matching for 1.88 GHz testing and small signal measurements were completed. Power testing will be performed in early January.
- 3.3 There was only a minimum of power testing at PHO while awaiting the new MNM capacitors. At this time the MNM capacitor wafers are being diced and completed devices using the new capacitors should be ready for RF evaluation by January 13th. The typical RF power performance achieved during December reflects the issues associated with inefficient input matching and the lack of emitter ballasting:
- $$F_o = 5.5 \text{ GHz}, V_{cc} = 5 \text{ V}, I_q = 25 \text{ ma}$$
- $$P_o = 25 \text{ dBm}, G = 9 \text{ dB}, \text{Eff}_c = 22\%$$
- 3.4 The new design MNM capacitors have completed wafer fabrication at BSO. The target 0.5 pf values were slightly high measuring 0.65 - 0.7 pf; however, since it was felt that capacitors in the range of 0.5 - 1.5 pf were needed, these initial capacitor lots should be very usable for this program. Two wafers of these capacitors were shipped to PHO on December 24th for use in the high frequency testing of SiGe2 and BUR50 devices. Two wafers were retained for device testing at CR&D and for measurement of capacitor-Q at BSO.
- 3.5 A new wafer lot (4 wafers) was started at BSO utilizing the SiGe2 design on NRL epitaxial material to investigate the effect of UHFCVD polysilicon on the interfacial oxide layer at the emitter-base junction. SIMS analysis will be performed to verify the SiGe and dopant levels in the base structure.

#### **4.0 Problems and Proposed Solutions**

- 4.1 The high vacuum pump system on the UHVCVD reactor has been upgraded by the addition of a Roots Blower between the Turbo Pump and the Mechanical Roughing / Backing Pump. This upgrade should produce higher pumping velocities and aid in the removal of trace oxygen and water vapor.

This upgrade was funded entirely by internal M/A-COM BSO budgets and while this upgrade is not in the development scope of the NRL contract, the change to the pump package will be used for all new SiGe epitaxial growth.

The changes to the pump package has required recharacterization of the growth parameters associated with the UHVCVD system. The wafer starts mentioned in paragraph 3.5 are utilizing material produced with the new pumping configuration.

**5.0 Objectives for the Next Reporting Period**

- 5.1 The new MNM capacitors will be used at PHO to further evaluate the power performance and load-pull parameters of SiGe2 and BUR50 devices at 6 GHz.
- 5.2 Measurements will be made at BSO to determine the MNM capacitor Q-value at frequencies to 8 GHz.
- 5.3 The new MNM capacitors will be used at CR&D to further evaluate the power performance and load-pull parameters of SiGe2 and BUR50 devices at 6 GHz.
- 5.4 Testing will resume at CR&D to compare the RF performance of the poly-emitter and poly-all processes at 1.88 GHz.
- 5.5 The design of the emitter ballasting resistors will be completed at BSO and the appropriate mask levels purchased.

Respectfully,

M/A-COM Inc.



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